CLAIMS

1. A method to locate a fault from one end of a section of a power line (A-B) by means of measurements of current, voltage and angles between the phases at a first (A) end of said section, and that upon detection of a fault condition between said first end and a second end of said power line,
characterised by
-calculating symmetrical components of currents for said current and voltage measure at said first end,
-calculating a distance (d) from said first end (2) to the fault (F) the distance (d) to the fault using a quadratic equation of the form:

$$B_2 d^2 + B_1 d + B_0 = 0$$

where:

$$B_2 = A_{2\_\mathrm{Re}} A_{00\_\mathrm{Im}} - A_{2\_\mathrm{Im}} A_{00\_\mathrm{Re}}$$

$$B_1 = A_{1\_\mathrm{Re}} A_{00\_\mathrm{Im}} - A_{1\_\mathrm{Im}} A_{00\_\mathrm{Re}}$$

$$B_0 = A_{0\_\mathrm{Re}} A_{00\_\mathrm{Im}} - A_{0\_\mathrm{Im}} A_{00\_\mathrm{Re}}$$

2. A method according to claim 1, **characterised** by calculating the distance (d) to the fault using an equation of the form:

$$\underline{K}_1 \underline{Z}_{1L} d^2 + (\underline{L}_1 \underline{Z}_{1L} - \underline{K}_1 \underline{Z}_{AA\_p}) d - \underline{L}_1 \underline{Z}_{AA\_p} + R_F \underline{M}_1 \frac{(\underline{a}_{F1} \Delta \underline{I}_{AA1} + \underline{a}_{F2} \underline{I}_{AA2})}{\underline{I}_{AA\_p}} = 0 \qquad (8)$$

where:

$\underline{Z}_{AA\_p} = \dfrac{\underline{V}_{AA\_p}}{\underline{I}_{AA\_p}}$ – calculated fault loop impedance.

3. A method according to any of claims 1 or 2, **characterised** by calculating the distance (d) to the fault using an equation of the form:

$$\underline{A}_2 d^2 + \underline{A}_1 d + \underline{A}_0 + \underline{A}_{00} R_F = 0$$

where:

$$\underline{A}_2 = A_{2\_\mathrm{Re}} + \mathrm{j} A_{2\_\mathrm{Im}} = \underline{K}_1 \underline{Z}_{1LA}$$

$$\underline{A}_1 = A_{1\_\mathrm{Re}} + \mathrm{j} A_{1\_\mathrm{Im}} = \underline{L}_1 \underline{Z}_{1LA} - \underline{K}_1 \underline{Z}_{AA\_p}$$

$$\underline{A}_0 = A_{0\_Re} + jA_{0\_Im} = -\underline{L}_1 \underline{Z}_{AA\_p}$$

$$A_{00\_Re} + jA_{00\_Im} = \frac{\underline{M}_1(\underline{a}_{F1}\Delta\underline{I}_{AA1} + \underline{a}_{F2}\underline{I}_{AA2})}{\underline{I}_{AA\_p}}$$

$\underline{Z}_{AA\_p} = \frac{\underline{V}_{AA\_p}}{\underline{I}_{AA\_p}}$ = calculated fault loop impedance

$\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ = coefficients gathered in TABLE 3.

4. A method according to any of claims 1-3, **characterised** by -determining source impedance at said first end as a representative value, and
-determining a value for source impedance at said second end as a representative value.

5. A method according to any of claims 1-4, **characterised** by calculating a value for impedance of an extra link (45, 55) between the terminals *A*, *B*, as having impedance for the positive sequence equal to:

$$\left(\underline{Z}_{1LB\&AB} = \frac{\underline{Z}_{1LB}\underline{Z}_{1AB}}{\underline{Z}_{1LB} + \underline{Z}_{1AB}} \right)$$

where

$\underline{Z}_{1AB}$ = impedance for the positive sequence of the extra link,

$\underline{Z}_{1LA}$ = positive sequence impedance of the healthy line.

6. A method according to any of claims 1-5, **characterised** by calculating symmetrical components of currents for said current and voltage measured at said first end by:
-inputting instantaneous phase voltages (30a),
-filtering (33a) the values to determine the phasors, and
-calculating (34a) phasors of symmetrical components of voltages.

7. A method according to any of claims 1-6, **characterised** by calculating symmetrical components of currents for said current and voltage measured at said first end by

inputting instantaneous phase currents and instantaneous zero sequence current from a healthy line(30b),
-filtering (33b) the values to determine the phasors, and
-calculating (34b) phasors of symmetrical components of currents.

8. A method according to any of claims 1-7, **characterised** by determining a compensation for shunt capacitance by means of an equation of the form:

$$B_2^{comp\_1}(d_{comp\_1})^2 + B_1^{comp\_1} d_{comp\_1} + B_0^{comp\_1} = 0 \qquad (22)$$

where:

$$B_2^{comp\_1} = A_{2\_Re}^{comp\_1} A_{00\_Im}^{comp\_1} - A_{2\_Im}^{comp\_1} A_{00\_Re}^{comp\_1}$$

$$B_1^{comp\_1} = A_{1\_Re}^{comp\_1} A_{00\_Im}^{comp\_1} - A_{1\_Im}^{comp\_1} A_{00\_Re}^{comp\_1}$$

$$B_0^{comp\_1} = A_{0\_Re}^{comp\_1} A_{00\_Im}^{comp\_1} - A_{0\_Im}^{comp\_1} A_{00\_Re}^{comp\_1}$$

9. A method according to claim 8, **characterised** by determining a compensation for shunt capacitance by means of an equation of the form:

$$\underline{A}_2^{comp\_1}(d_{comp\_1})^2 + \underline{A}_1^{comp\_1} d_{comp\_1} + \underline{A}_0^{comp\_1} + \underline{A}_{00}^{comp\_1} R_F = 0 \qquad (21a)$$

where:

$$\underline{A}_2^{comp\_1} = A_{2\_Re}^{comp\_1} + \mathrm{j}A_{2\_Im}^{comp\_1} = \underline{K}_1 \underline{Z}_{1L}^{long}$$

$$\underline{A}_1^{comp\_1} = A_{1\_Re}^{comp\_1} + \mathrm{j}A_{1\_Im}^{comp\_1} = \underline{L}_1 \underline{Z}_{1L}^{long} - \underline{K}_1 \underline{Z}_{A\_p}^{comp\_1}$$

$$\underline{A}_0^{comp\_1} = A_{0\_Re}^{comp\_1} + \mathrm{j}A_{0\_Im}^{comp\_1} = -\underline{L}_1 \underline{Z}_{A\_p}^{comp\_1}$$

$$\underline{A}_{00}^{comp\_1} = A_{00\_Re}^{comp\_1} + jA_{00\_Im}^{comp\_1} = \frac{\underline{M}_1(\underline{a}_{F1}\Delta\underline{I}_{AA1} + \underline{a}_{F2}\underline{I}_{AA2})}{\underline{I}_{A\_p}^{comp\_1}}$$

$\underline{Z}_{A\_p}^{comp\_1} = \frac{\underline{V}_{A\_p}}{\underline{I}_{A\_p}^{comp\_1}}$ - fault loop impedance calculated from:

$\underline{V}_{A\_p}$ - original (uncompensated) fault loop voltage,

$\underline{I}_{A\_p}^{comp\_1} = \underline{a}_1 \underline{I}_{A1\_comp\_1} + \underline{a}_2 \underline{I}_{A2\_comp\_1} + \underline{a}_0 \underline{I}_{A0\_comp\_1}$ - fault loop current composed of the positive (12), negative (16) and zero (17)

sequence currents obtained after deducing the respective capacitive currents from the original currents, and

$\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ = coefficients gathered in TABLE 3.

10. A method according to any of claims 1-9, **characterised** by measuring the source impedance $\underline{Z}_{1sA}$ at said first end A.

11. A method according to any of claims 1-9, **characterised** by
-measuring the source impedance $\underline{Z}_{1sB}$ at said second end B,
-sending a communication of the measured value of source impedance $\underline{Z}_{1sB}$ at said second end B to a fault locator at said first end A.

12. A method according to any of claims 1-11, **characterised** by
-determining the zero sequence current from the healthy line of a section of parallel power lines,
-calculating a distance to a fault for the parallel line section.

13. A method according to claim 12, **characterised** by determining distance to a single phase to ground fault without measurements from an operating healthy parallel line by means of complex coefficients $\underline{P}_0$ according to a formula of the form:

$$\underline{P}_0 = \frac{\underline{Z}_{0LB} - \underline{Z}_{0m}}{\underline{Z}_{0LA} - \underline{Z}_{0m}}$$

and $\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ according to

$$\underline{K}_1 = -\underline{Z}_{1LA}(\underline{Z}_{1sA} + \underline{Z}_{1sB} + \underline{Z}_{1LB})$$

$$\underline{L}_1 = -\underline{K}_1 + \underline{Z}_{1LB}\underline{Z}_{1sB}$$

$$\underline{M}_1 = \underline{Z}_{1LA}\underline{Z}_{1LB} + \underline{Z}_{1LA}(\underline{Z}_{1sA} + \underline{Z}_{1sB}) + \underline{Z}_{1LB}(\underline{Z}_{1sA} + \underline{Z}_{1sB})$$

14. A method according to claim 12, **characterised** by determining distance to a single phase to ground fault without

measurements from switched off and grounded parallel line by means of complex coefficients $\underline{P}_0$ according to

$$\underline{P}_0 = -\frac{\underline{Z}_{0LB}}{\underline{Z}_{0m}}$$

and $\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ according to

$$\underline{K}_1 = -\underline{Z}_{1LA}$$

$$\underline{L}_1 = \underline{Z}_{1LA} + \underline{Z}_{1sB}$$

$$\underline{M}_1 = \underline{Z}_{1sA} + \underline{Z}_{1sA} + \underline{Z}_{1LA}$$

15. A method according to claim 12, **characterised** by determining distance to a single ground fault using a first order formula (27a,b,c) of the form:

$$d = \frac{imag\{\underline{V}_{AA\_p}[3(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}{imag\{(\underline{Z}_{1LA}\underline{I}_{AA\_p})[3(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}$$

16. A method according to claim 12, **characterised** by determining distance to a phase-to-phase ground fault using pre-fault measurements and a first order formula (28a,b,c) of the form:

$$d = \frac{imag\{\underline{V}_{AA\_p}[\underline{W}(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}{imag\{(\underline{Z}_{1LA}\underline{I}_{AA\_p})[\underline{W}(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}$$

17. A method according to claim 12, **characterised** by determining distance to a phase-to-phase ground fault avoiding pre-fault measurements and using a first order formula (29a,b,c) of the form:

$$d = \frac{imag[(\underline{V}_a + \underline{V}_b)(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})^*]}{imag[\underline{Z}_{1LA}(\underline{I}_a + \underline{I}_b + 2\underline{k}_0\underline{I}_{AA0} + 2\underline{k}_{0m}\underline{I}_{AB0})(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})^*]}$$

18. A device for locating a fault from one end of a section of a power line (A-B) having means for receiving and storing measurements of current, voltage and angles between the phases at one first end (A), means for receiving and storing a detection of a fault condition between said first and second ends (A,B), **characterised** by:
-means for calculating symmetrical components of currents for said current and voltage measured at said first end,
-means for calculating a distance (d) from said first end (2) to the fault (F).

19. A device according to claim 18, **characterised** by comprising:
-means for determining a value for source impedance at said first end,
-means for determining a value for source impedance at said second end.

20. A device according to any of claims 18-19, **characterised** by comprising:
-means for receiving a measurement of source impedance at said first end A.

21. A device according to any of claims 18-20, **characterised** by comprising:
-means for receiving a measurement of source impedance made at said second end B.

22. A device according to any of claims 18-21, **characterised** by comprising means to receive a measured value (9) for remote source impedance at said second end (B) communicated by means of a communication channel (60).

23. Use of a fault locator device according to any of claims 18-22, by a human operator to supervise a function in an electrical power system.

24. Use of a fault locator device according to any of claims 18-22, by means of a process running on one or more computers to supervise and/or control a function in an electrical power system.

25. Use of a fault locator device according to any of claims 18-22, to locate a distance to a fault in a power transmission or distribution system.

26. Use of a device according to any of claims 18-22, for locating a fault on parallel power lines.

27. A computer program comprising computer code means and/or software code portions for making a computer or processor perform any of the steps of claims 1-17.

28. A computer program product according to claim 27 comprised in one or more computer readable media.

29. A data communication signal for locating a fault in a section of a power line included in a data transmission comprising a value of a measurement of source impedance made in respect of a remote and second (B) end of said section of a power line.

30. A graphic user interface for displaying a location of a fault in a section of a power line wherein a value is displayed for a distance (d) of said fault from a first end (A) of said power line.

31. A graphic user interface according to claim 30, **characterised** in that the value displayed for the distance (d) is combined with a graphical representation of the relevant power line section or network.

32. A graphic user interface according to claim 30, **characterised** in that the value displayed for the distance (d) is arranged to be displayed upon activation of a part of the graphical representation of the relevant power line section or network using a computer mouse or similar computer display selection means.